MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023 (TERM ID 2220)

ETM2126 – INFORMATION THEORY AND ERROR CONTROL CODING

(TE)

07 JULY 2023
9.00 A.M. – 11.00 A.M.
(2 Hours)

INSTRUCTION TO STUDENT

1. This Question paper consists of 4 pages (including this cover page) with 4 Questions only.

2. Attempt all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given. The total marks are 100.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Identify and construct the decision tree for each prefix code in **Table Q1**.

[4 marks]

Table Q1

Symbol	Code I	Code II	Code III
s_0	0	0	00
s_1	01	11	01
s_2	001	101	10
s_3	0010	1011	110
s_4	0011	10001	111

(b) A discrete memoryless source has an alphabet of three symbols with their probabilities for its output, as given in **Table Q2**:

Table Q2

Symbol	s_0	s_1	s_2
Probability	0.45	0.35	0.2

(i) Generate the Huffman code for this source and find the coding efficiency.

[8 marks]

(ii) Let the source be extended to order two. Apply Huffman algorithm to the resulting extended source, and find the average codeword length of the new code and the coding efficiency.

[13 marks]

Continued...

Question 2

(a) A binary channel matrix is given by:

$$P(Y|X) = \begin{bmatrix} \frac{2}{3} & \frac{1}{3} \\ \frac{1}{10} & \frac{9}{10} \end{bmatrix}$$

If the probability of transmitting x_2 is equal to the probability of transmitting x_1,

(i) Sketch the channel diagram.

[4 marks]

(ii) Find the output probabilities $P(y_1)$ and $P(y_2)$.

[4 marks]

(iii) Determine the entropy of the channel input $H(X)$, and all the conditional probabilities, $P(x_k|y_j)$, k=1,2 and j=1,2.

[10 marks]

(b) A Gaussian channel has a bandwidth of 8 kHz and two-sided noise power spectral density ($N_0/2$) of $1\text{x}10^{-14}$ Watt/Hz. If the time required to transmit 10 kbytes is 2 seconds, find the minimum transmitted power for a reliable transmission over the channel. (Hint: 1 byte = 8 bits)

[7 marks]

Question 3

For a (7,4) systematic linear block code, the three parity check bits are formed from the following equations:

$$b_0 = m_1 + m_2 + m_3$$
$$b_1 = m_0 + m_1 + m_2$$
$$b_2 = m_0 + m_2 + m_3$$

(a) Find the generator matrix and the parity-check matrix for this code.

[6 marks]

(b) Construct all possible codewords and determine the Hamming weight for each codeword.

[16 marks]

(c) Find the minimum distance of the code and determine how many errors can the code correct.

[3 marks]

Continued...

Question 4

Consider a Trellis coded modulation (TCM) system that uses a rate-½ convolutional encoder to encode one information bit while the second information bit is left uncoded. The generator polynomials for the convolutional encoder are given as follows:

$$g^{(1)}(D) = 1 + D^2$$
$$g^{(2)}(D) = D$$

(a) Draw the block diagram of the TCM system which consists of the convolutional encoder and the signal mapper.

[10 marks]

(b) Construct the state transition table.

[8 marks]

(c) Draw the state transition diagram.

[7 marks]

End of Paper